# The Origin of Clay Minerals in Soils of King George Island, South Shetland Islands, West Antarctica and its Implication to the Clay Mineral Compositions of Marine Sediments

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1. Methods of quantitative X-ray diffraction (XRD) analysis

Soil samples were dried, sieved (< 200 mesh), and ground in an agate mortar for XRD. After packed in the circular cavity of holder, the XRD pattern was obtained on a Siemens D5005 instrument using Cu Kα radiation equipped with a diffracted-beam monochromator in the range of 3-40° $2\theta$. The < 2 μm size fraction was separated from some smectite-rich samples by sedimentation and centrifugation of suspension and further identified after ethylene glycolation and heating at 350 °C and 550 °C.

Mineral composition of soil samples was determined by the external standard method of Chung (1974). This method requires a reference intensity ratio (RIR), the ratio of the integrated intensity of a selected diffraction line of a standard mineral to the integrated intensity of the (113) diffraction line of synthetic corundum powder (1 μm) in a 1:1 mixture by weight. Mineral compositions in a mixture of m ninerals are calculated as follows:

$$X_i = \left( \frac{K_{i,n}}{I_{i,n}} \sum_{j=1}^{m} \frac{I_{j,n}}{K_{j,n}} \right)^{-1}$$

Where $X_i$ is the unknown weight fraction of phase i in the sample, $K_{i,n}$ and $K_{j,n}$ are the RIR for diffraction line n of phase i and j, $I_{i,n}$ and $I_{j,n}$ are the integrated intensity of diffraction line n of phase i and j respectively, and m is the number of phases in the mixture. RIR was measured for the (001) diffraction line of illite, pyrophyllite, smectite,

and kaolinite, (002) of chlorite, (2,0,-1) of plagioclase, (100) of quartz, and (110) of amphibole. Standard samples of illite, pyrophyllite, smectite, chlorite, quartz, and plagioclase were separated from the soils and bedrocks of the Barton Peninsula, and for kaolinite from Dry Branch, USA, for hornblende from Sancheong, Korea. Overlapping peaks were separated with software (PROFILE 1.0) installed in the Siemens D5005 instrument. The (001) line of smectite overlapped with the (001) line of chlorite in many samples. The peak area of smectite was obtained by subtracting the portion of chlorite from the total area of overlapping peaks. The average integrated-intensity ratio of (001) to (002) of chlorite was estimated as 0.51 (± 0.08) from the XRD patterns of 14 bedrock samples.

There are many sources of errors: differences in structure and chemical composition between samples and standards, preferred orientation, overlapping peaks, counting statistics, and peak versus background statistics (Bish and Chipera 1986). We could not estimate all the errors. However, data obtained through standardized procedures can reasonably be interpreted to show the characteristic distribution pattern of clay minerals in soils. This method has an advantage over the method of Biscaye (1965) commonly used for the quantitative analysis of clay minerals in fine-grained deep-sea sediments because it includes many more minerals that occur in the soils. Clay minerals might be either the major component of soils or very small in absolute quantity compared to nonclay minerals. They may occur as inclusions in mineral and rock fragments. Hence, relative abundances of only four clay minerals in < 2 $\mu m$ fractions cannot represent their realistic distribution patterns in soils comprising a varying amount of nonclay minerals such as quartz and plagioclase depending on the bedrock lithology.

## 2. References

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